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(54)【発明の名称】耐酸化性に優れた永久磁石

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## (57)【特許請求の範囲】

【請求項1】原子百分率で10~20%のR(ここでRはYを含む希土類元素), 5~15%のB, 残部Feよりなる磁性合金粉末と, 体積構成比で0~10% (0は含まず) の非磁性金属M(ここでMは, Al, Zn, S, In, Ga, Ge, Sn, Te, Cu, Pbの内の少なくとも一種の元素, これらの元素間の化合物, これら元素と希土類元素との合金, 及び又はこれらの元素とBとの合金) の粉末との混合粉末, 又はその成形体を300~1100°Cの温度下で熱間加圧成形して得られる永久磁石であって, 前記非磁性金属Mからなるマトリックス中に前記磁性合金R<sub>2</sub>Fe<sub>14</sub>Bの結晶粒が分散されたR<sub>2</sub>T<sub>14</sub>B-M系永久磁石と, 前記R<sub>2</sub>T<sub>14</sub>B-M系永久磁石の表面に被覆された耐酸化性メッキ層とを有することを特徴とする耐酸化性に優れた永久磁石。

## 【発明の詳細な説明】

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## 【産業上の利用分野】

本発明はYを含む希土類元素(以下Rと略記する)とFe, Bより成る金属間化合物及び非磁性元素MよりなるR<sub>2</sub>Fe<sub>14</sub>B-M系磁石材料において, その耐酸化性を改善したR<sub>2</sub>Fe<sub>14</sub>B-M系磁石材料に関するものである。

## 【従来技術】

R-Fe-B系永久磁石については, 特開昭59-46008公報や, 日本応用磁気学会第35回研究資料(昭和59年5月)に述べられている。

これら文献には, R<sub>2</sub>Fe<sub>14</sub>B相を主相とするR-Fe-B系合金粉末を, 常圧焼結法により永久磁石を製造する方法が示されているが, そこでの焼結法はSm-Co系永久磁石の製造で確立した技術を適用したものである。

この常圧焼結法によりR-Fe-B系永久磁石を製造する場合, その緻密化は, 高Nd相(液相)の出現に伴う液

相焼結によって成される。それ故、焼結体中には、磁性相である主相である $R_2Fe_{14}B$ 相、非磁性相であるB富相、酸化物相の他に液相成分相であるNd富相が存在する。一般に本系磁石合金では、これら各相の存在比に対応して、磁石特性（特にBr、(BH) ...）は、変化する。現状のプロセスにより得られる焼結体中におけるこれら非磁性相の体積構成比は約10%以上である。

また常圧焼結の場合には、充分な緻密化を得るために、液相成分を体積構成比で5%以上必要とするため、常圧焼結により得られる磁石特性には、限界があった。さらにR-Fe-B系磁石の常圧焼結は900~1200°Cという高温で行なわれるため収縮率が大きく、焼結体表面に変質相を生ずるため、寸法精度による歩留りにも限界がある。

一方、超急冷（メルトスピニング法による）物質の焼純法による方法（特開昭60-100402）により作製したR-Fe-B薄帯は、磁気的に等方性を有するため焼結磁石に比べ磁石特性が、格段に低く、またこの薄帯を用いて塑性変形により異方性化しても薄帯中の結晶組織が、本質的に等方的であるため、焼結磁石と同等の特性は望めない。

また、射出成形法及びボンド磁石法（特開昭59-219904）の場合、磁性粉末間の空隙を埋める非磁性バインダーの量が体積構成比で少なくとも20%以上を必要とするため、特性は他法に比べ極めて低い。

#### [従来技術の問題点]

これらR-Fe-B系磁石の耐食性に関しては、特に焼結法により得られたR-Fe-B系磁石の耐食性が悪い。これは大気中で極めて酸化し易い希土類元素、Feを含有するためであり、特に組成比率でほとんどRのみである液相成分相のR富相の耐食性の低さに起因している。それ故、このR-Fe-B系磁石を磁気回路などの装置に組込んだ場合、磁石の酸化による特性の劣化、バラツキが生ずる。又、磁石より発生する酸化物の飛散による周辺部品の汚染の問題があった。

これら耐酸化性改善については、特開昭60-54406号公報に示されている。しかしながら、該公報に示される耐酸化性改善方法においても、その処理工程中に多量の水を使用するため、処理工程中に特にR-富相が酸化する恐れがあり、耐酸化性が充分とは言い難い。すなわちメッキの持つ耐酸化性をR-Fe-B系磁石に付与することは極めて困難であった。

本発明は、これら問題点を解決するもので、その目的は、

- (1) 非磁性金属相量の低減による特性向上
- (2) 製品寸法精度向上による歩留り改善
- (3) 磁石中のR富相を低減させることにより、本来メッキの持つ耐酸化性を付与することによる耐食性の向上

を実現した磁石材料を提供することにある。

#### [問題点を解決するための手段]

上記目的を達成するため、本発明は原子百分率で10~20%のR（ここでRはYを含む希土類元素）、5~15%のB、残部Feよりなる磁性合金粉末と、体積構成比で0~10%（0は含まず）の非磁性金属M（ここでMは、Al、Zn、S、In、Ga、Ge、Sn、Te、Cu、Pbの内の少なくとも一種の元素、これらの元素間の化合物、これら元素と希土類の合金、及び又はこれらの元素とBとの合金）の粉末との混合粉末、又はその成形体を300~1100°Cの温度下で熱間加圧成形して得られる永久磁石であって、前記非磁性金属Mからなるマトリックス中に前記磁性合金R<sub>2</sub>Fe<sub>14</sub>Bの結晶粒が分散されたR<sub>2</sub>T<sub>14</sub>B-M系永久磁石と、前記R<sub>2</sub>T<sub>14</sub>B-M系永久磁石の表面に被覆された耐酸化メッキ層とを有することを特徴とする。ここで非磁性金属はZn、Al、S、In、Ga、Ge、Sn、Te、Cu、Pbの少なくとも一種の元素、これら元素間の化合物、これら元素と希土類元素との合金、及びまたはこれら元素とBとの合金で、粉末、あるいは磁性粉末への物理的及び化学的表面被覆層のいずれでもよい。また熱間加圧成形はいわゆるホットプレス、熱間静水圧プレス、押し出し、のいずれでも可能であるが、製品寸法精度の点から、ホットプレス、押し出しが適している。

この熱間加圧成形体の表面に耐酸化性メッキ層を形成する。

すなわち、本発明では、

- 1) 非磁性金属を用いて加圧成形することによる緻密化の促進
- 2) 磁性粒子を滑らかな、界面で包み込むことによる磁石の高保磁力化
- 3) 热間加圧成形を用いることにより、非磁性相の流動及び磁性相の塑性変形を利用した非磁性相の減少、及び短時間の緻密化による非磁性金属と磁性相との反応の抑制を両者に起因するBrの向上
- 4) 磁石中のR富相を低減させることによりメッキ本来の持つ耐酸化性を、磁石製品に付与することによる耐食性の向上。

以上の機能により製品寸法精度が高く、高い磁石特性を有し、しかも耐酸化性に優れた磁石材料を提供することができる。

40 本発明が適用される永久磁石材料は、一般式  

$$(R_{1-x}, Fe_x, B_y)_{1-t} M_t \quad \dots (1)$$
 で示されるが、ここで式中のRはYを含む希土類元素のうち一種又は二種以上が、用いられる。また(1)式において  
 $x, y$ は原子分率で  $0.65 \leq x \leq 0.85, 0.05 \leq y \leq 0.15$ , tは体積構成比で  $0 < t \leq 0.1$   
 である。Feの量が多すぎるとBrは向上するもののHcは極端に低下し、少なすぎるとBrの低下により(BH) ... が減少するため、原子分率で  $0.65 \leq x \leq 0.85$ とした。Bは50 磁石特性の向上に著しい効果をもたらすが、原子分率で

0.15を越えると、特性劣化を生ずるため、 $0.05 \leq y \leq 0.15$ とした。

また非磁性金属Mは、量が多すぎるとBrの低下が著しく、本発明の目的に合わないため、体積構成比で $0 < t \leq 0.1$ とする。

(1) で示される磁石材料はR<sub>1</sub>...F<sub>y</sub>B<sub>t</sub>の組成を有する粉末と非磁性金属元素及び合金M粉末の混合粉末、又は圧粉体を300~1100°Cの温度範囲にて、5~5000kg/cm<sup>2</sup>の圧力化で熱間加圧成形を行うことにより製造される。

ここで熱間加圧成形時の温度を300~1100°Cとしたのは、300°C未満では成形体の充分な緻密化が図れず、1100°C以上では、R-Fe-B磁性粒子の粒成長、及びこの磁性相と非磁性元素又は合金との反応が、顕著となり良好な磁石特性が得られないためである。

また熱間加圧成形圧力は5kg/cm<sup>2</sup>未満では、成形体の充分な、緻密化が図れないため5kg/cm<sup>2</sup>以上とする必要がある。

さらに、上記製法により製造された磁石材料に、耐酸化性を付与するためにメッキ処理を行う。このメッキ処理は、通常行なわれているメッキ処理方法を用いればよく、Ni、Cr、Zn等の耐酸化性を有する金属又は合金メッキ、あるいはNiとCr等の複合メッキであればよい。その処理方法は、無電解又は電解メッキ等で行なわれ、通常Fe系材料に適用されるCu下地メッキ等を用いることもできる。

またその膜厚は寸法精度、コスト面、耐酸化性の面より25μm以下が好ましい。

以下その実施例について述べる。

第一表

表面処理	無処理			Cu下地メッキ+Hiメッキ		
	特性 組成	Br (kG)	(BH) <sub>max</sub> (MGoe)	Hc (kOe)	Br (kG)	(BH) <sub>max</sub> (MGoe)
Nd <sub>1.2.3</sub> Fe <sub>7.7</sub> B <sub>5.7</sub> Zn <sub>5</sub>	13.5	42.2	10.8	13.4	42.0	10.5
Nd <sub>1.2.4</sub> Fe <sub>7.7.2</sub> B <sub>5.7</sub> Al <sub>4.7</sub>	14.0	45.0	12.5	14.0	45.2	12.8
Nd <sub>1.2.8</sub> Fe <sub>7.8.6</sub> B <sub>5.8</sub> In <sub>3</sub>	13.6	42.1	10.5	13.5	42.0	10.9
Nd <sub>1.2.5</sub> Fe <sub>7.7.7</sub> B <sub>5.8</sub> S <sub>4</sub>	13.9	42.0	10.0	13.7	41.0	10.2
Nd <sub>1.2.5</sub> Fe <sub>7.8</sub> B <sub>5.8</sub> Ga <sub>2.7</sub>	13.5	40.5	11.5	13.4	40.7	11.0
Nd <sub>1.2.5</sub> Fe <sub>7.8</sub> B <sub>5.8</sub> Ge <sub>2.7</sub>	13.7	40.0	10.8	13.7	40.0	10.5
Nd <sub>1.2.7</sub> Fe <sub>7.8.3</sub> B <sub>5.9</sub> Te <sub>2.1</sub>	13.8	38.0	7.5	13.7	38.2	7.0
Nd <sub>1.2.7</sub> Fe <sub>7.8.7</sub> B <sub>5.9</sub> Sm <sub>2.8</sub>	13.6	41.0	10.6	13.6	41.2	11.0
Nd <sub>1.2.2</sub> Fe <sub>7.6</sub> B <sub>5.6</sub> Cu <sub>8.1</sub>	13.4	39.0	9.0	13.3	38.8	9.2
Nd <sub>1.2.8</sub> Fe <sub>7.9.1</sub> B <sub>5.9</sub> Pb <sub>2.2</sub>	13.3	38.5	9.5	13.3	38.0	9.6

<実施例-1>

純度95%以上のNd-Fe-Bを用いて、アルゴン雰囲気中で高周波加熱によりNd<sub>1</sub>, Fe<sub>8</sub>, B<sub>6</sub>の組成を有するNd<sub>2</sub>Fe<sub>14</sub>B相を主相とするインゴットを得た。次にこのインゴットを、粗粉碎した後、ボールミルを用いて、平均粒径約4μmに湿式粉碎した。次にこの得られた微粉末を混合比で、95vol%とし、残部5vol%を純度99.9%以上のZn, Al, S, In, Ga, Ge, Te, Cu, Pb粉末のうちの一類とした混合物を調整し、この混合粉末をボールミルにて均一分散

10 混合して、9種類の、Nd<sub>1</sub>, Fe<sub>8</sub>, B<sub>6</sub>と非磁性粉末の混合粉末を得た。これら、粉末を、20KOe磁界中にて1.0t/cm<sup>2</sup>の圧力で成形した後真空中600°C前後の温度下で1.0t/cm<sup>2</sup>の圧力を加え、15分間ホットプレスした。次に得られた磁石材料を、Cuの下地メッキをした後、電解Niメッキをほどこした。このCu+Niのメッキ膜厚を測定したところ最小で5μm最大で15μmであった。これらメッキ処理をされた試験片、及び比較のためメッキ処理をしていないホットプレスより得られた磁石材料、及び上記と同様メッキ処理を施したNd<sub>1</sub>, Fe<sub>8</sub>, B<sub>6</sub>の組成を有する焼結磁石の20 磁石特性を第一表に示す。またこれら磁石を48時間塩水噴霧試験(JIS-Z-2371)を行った結果、本発明によるホットプレスにて得られた磁石に耐酸化性のCu下地メッキ+Niメッキ処理したものは何ら変化を生じていなかった。しかし、メッキ処理を施していないホットプレスにて得られた磁石表面には全面に赤さびを生じていた。またさらに焼結法により得られたNd<sub>1</sub>, Fe<sub>8</sub>, B<sub>6</sub>の組成を有する焼結磁石にCu+Niメッキした試料も赤さびが生じメッキ膜のはく離が生じていた。

表面処理 組成	無処理			Cu下地メッキ+Hiメッキ		
	Br (kG)	(BH) <sub>max</sub> (MGoe)	Hc (kOe)	Br (kG)	(BH) <sub>max</sub> (MGoe)	Hc (kOe)
Nd <sub>1.5</sub> Fe <sub>8.1</sub> B <sub>6</sub>	1.0	0.2	<1	1.0	0.3	<1

比較例(焼結体)

Nd <sub>1.5</sub> Fe <sub>8.1</sub> B <sub>7</sub>	12.8	38.2	9.5	12.8	38.0	9.0
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## 〔発明の効果〕

以上述べたように本発明によればR<sub>2</sub>Fe<sub>14</sub>B相を主相とする磁性粉末と、非磁性金属粉末より得られる混合粉末又は圧粉末体を熱間加圧成形を行うことにより得られる永久磁石に耐酸化性に優れた金属メッキ処理を行うこと

10 により従来の焼結法により得られるR-Fe-B系磁石よりも、高い磁石特性を有し、耐酸化性に優れた永久磁石を得ることができ、さらに従来の焼結法に比べ低温で成形体の緻密化が図れ、製品寸法精度向上が実現できるため、工業上きわめて有益である。

フロントページの続き

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- 3.In the drawings, any words are not translated.

(57) [Claim(s)]

[Claim 1] The end of a magnetic alloy powder it consists of R (rare earth elements with which R contains Y here), and 5 – 15% of B and Remainder Fe with atomic percent, [ 10 – 20% of ] It is 0 – 10% (0 does not contain) of non-magnetic metal M (M here) at volume percentage. the compound between at least a kind of elements of aluminum, Zn, S, In, Ga, germanium, Sn, Te, Cu, and the Pb(s), and these elements, and the alloy of these elements and rare earth elements -- and — or mixed powder with the powder of the alloy of such elements and B, or its Plastic solid The R2T 14 B-M system permanent magnet with which the crystal grain of said magnetic alloy R2Fe14B was distributed in the matrix which is the permanent magnet obtained by carrying out pressing between heat under the temperature of 300–1100 degrees C, and consists of said non-magnetic metal M, The permanent magnet excellent in the oxidation resistance characterized by having the oxidation-resistant deposit covered by the front face of said R2T 14 B-M system permanent magnet.

[Detailed Description of the Invention]

[Industrial Application]

This invention relates to the R2Fe14 B-M system magnet ingredient which has improved the oxidation resistance in the R2Fe14 B-M system magnet ingredient which consists of the rare earth elements (it outlines Following R) containing Y, an intermetallic compound which consists of Fe and B, and a nonmagnetic element M.

[Description of the Prior Art]

The R-Fe-B system permanent magnet is stated to a JP,59-46008,A official report and the 35th time study materials (May, Showa 59) of the Magnetics Society of Japan.

Although the method of manufacturing a permanent magnet with an ordinary pressure sintering process is shown in the end of a R-Fe-B system alloy powder R2Fe14 B phase is made into the main phase, the sintering process of a there applies the technique

established by manufacture of a Sm-Co system permanent magnet to these reference. When manufacturing a R-Fe-B system permanent magnet with this ordinary pressure sintering process, that eburnation is accomplished by liquid phase sintering accompanying the appearance of a high Nd phase (liquid phase). So, in a sintered compact, Nd rich phase which is a liquid phase component phase exists besides B rich phase which is the R<sub>2</sub>Fe<sub>14</sub>B phase and nonmagnetic phase which are the main phase which is a magnetic phase, and an oxide phase. Generally with this system magnet alloy, a magnet property (especially Br, (BH)<sub>max</sub>) changes corresponding to the abundance ratio of each [these] phase. The volume percentage of these nonmagnetic phase in the sintered compact obtained according to the present process is about 10% or more.

Moreover, since in ordinary pressure sintering a liquid phase component was needed 5% or more by volume percentage in order to obtain sufficient eburnation, there was a limitation in the magnet property acquired by ordinary pressure sintering. Furthermore, since ordinary pressure sintering of a R-Fe-B system magnet is performed at the elevated temperature of 900-1200 degrees C, contraction is large, and since a deterioration phase is produced on a sintered compact front face, there is a limitation also in the yield by dimensional accuracy.

even if its magnet property is alike and low compared with a sintered magnet since the R-Fe-B thin band produced by the approach (JP,60-100402,A) by the glow pure method of the super-quenching (based on melt spinning process) matter has isotropy magnetically, and it anisotropy-izes by plastic deformation on the other hand using this thin band -- the crystalline structure in a thin band -- essential -- etc. -- since it is direction-like, a property equivalent to a sintered magnet cannot be desired.

Moreover, since the amount of the nonmagnetic binder which fills the opening between magnetic powder needs at least 20% or more by volume percentage in the case of an injection-molding method and a bond magnet method (JP,59-219904,A), a property is very low compared with other methods.

#### [Description of the Prior Art]

The corrosion resistance of the R-Fe-B system magnet obtained by the sintering process, especially concerning the corrosion resistance of these R-Fe-B system magnet is bad. This is because the rare earth elements which are very easy to oxidize in atmospheric air, and Fe are contained, and originates in the corrosion resistance lowness of R rich phase of the liquid phase component phase which is almost only R especially by the presentation ratio. So, when this R-Fe-B system magnet is built into equipments, such as a magnetic circuit, degradation of the property by magnetic oxidization and variation arise. Moreover, there was a problem of contamination of the circumference components

by scattering of the oxide generated from a magnet.

These oxidation resistance improvement is shown in JP,60-54406,A. However, also in the oxidation-resistant improvement approach shown in this official report, in order to use a lot of water into the down stream processing, a possibility that an R-rich phase may oxidize especially in down stream processing, and it is hard to say that oxidation resistance is enough. That is, it was very difficult to give the oxidation resistance which plating has to a R-Fe-B system magnet.

This invention is reducing R rich phase in the yield improvement (3) magnet by the improvement in improvement in property (2) product dimensional accuracy solving these troubles and according [ the object ] to reduction of (1) non-magnetic-metal \*\*\*\*. It is in offering the magnet ingredient which realized corrosion resistance improvement by giving the oxidation resistance which plating originally has.

#### [Means for Solving the Problem]

It is the end of a magnetic alloy powder this invention consists of R (rare earth elements with which R contains Y here), and 5 - 15% of B and Remainder Fe with atomic percent in order to attain the above-mentioned object, [ 10 - 20% of ] It is 0 - 10% (0 does not contain) of non-magnetic metal M (M here) at volume percentage. the compound between at least a kind of elements of aluminum, Zn, S, In, Ga, germanium, Sn, Te, Cu, and the Pb(s), and these elements, and the alloy of these elements and rare earth -- and -- or mixed powder with the powder of the alloy of such elements and B, or its Plastic solid The R2T 14 B-M system permanent magnet with which the crystal grain of said magnetic alloy R2Fe14B was distributed in the matrix which is the permanent magnet obtained by carrying out pressing between heat under the temperature of 300-1100 degrees C, and consists of said non-magnetic metal M, It is characterized by having the anti-oxidation deposit covered by the front face of said R2T 14 B-M system permanent magnet. here -- non-magnetic metal -- the compound between at least a kind of element of Zn, aluminum, S, In, Ga, germanium, Sn, Te, Cu, and Pb, and these elements, and the alloy of these elements and rare earth elements -- and -- or the alloy of these elements and B -- it is -- powder or magnetic powder -- any of a physical and chemical surface coating layer are sufficient. Moreover, although the pressing between heat is possible also at the so-called hotpress, a hot isostatic press, extrusion, and \*\*\*\*\*\*, a hotpress and extrusion are suitable from the point of product dimensional accuracy.

An oxidation-resistant deposit is formed in the front face of this pressing object between heat.

That is, at this invention, it is 1. Acceleration 2 of the eburnation by carrying out pressing using non-magnetic metal Raise 3 in the coercive force of the magnet by

wrapping a magnetic particle in a smooth interface The pressing between heat is used, The reduction using floating of a nonmagnetic phase, and the plastic deformation of a magnetic phase of a nonmagnetic phase, and improvement 4 in Br which originates control of the reaction of the non-magnetic metal and the magnetic phase by short-time eburnation in both Corrosion resistance improvement by giving the oxidation resistance which plating original has by reducing R rich phase in a magnet to a magnet product.

By the above function, product dimensional accuracy is high, it has a high magnet property, and the magnet ingredient which was moreover excellent in oxidation resistance can be offered.

The permanent magnet ingredient with which this invention is applied is general formula ( $R_{1-x-y}Fe_xBy$ )  $1-tMt$ . -- (1)

It comes out, and although shown, a kind or two sorts or more in the rare earth elements with which R in a formula contains Y are used here. Moreover, in (1) type,  $0.65 \leq x \leq 0.85$ ,  $0.05 \leq y \leq 0.15$ , and t of x and y are  $0 < t \leq 0.1$  in volume percentage at an atomic fraction. Although Br improved when there were too many amounts of Fe, Hc fell extremely, and if too few, in order that  $(BH)_{max}$  might decrease by lowering of Br, it was set to  $0.65 \leq x \leq 0.85$  with the atomic fraction. Although B brought remarkable effectiveness to improvement in a magnet property, if 0.15 was exceeded with an atomic fraction, since it would produce property degradation, it was set to  $0.05 \leq y \leq 0.15$ .

Moreover, when non-magnetic metal M has too many amounts, its lowering of Br is remarkable, and since the object of this invention is not suited, it is set to  $0 < t \leq 0.1$  by volume percentage.

The magnet ingredient shown by (1) is manufactured by performing the powder which has the presentation of  $R_{1-x-y}Fe_xBy$ , a non-magnetic metal element and the mixed powder of alloy M powder, or a green compact in a 300-1100-degree C temperature requirement, and performing pressing between heat by 5-5000kg/cm<sup>2</sup> pressure-ization. Temperature at the time of the pressing between heat was made into 300-1100 degrees C here, because eburnation with a Plastic solid sufficient at less than 300 degrees C was not able to be attained, but a reaction with grain growth of a R-Fe-B magnetic particle and this magnetic phase, a nonmagnetic element, or an alloy became remarkable above 1100 degrees C and a good magnet property was not acquired.

Moreover, by less than 5kg/cm<sup>2</sup>, since the pressing pressure between heat cannot attain eburnation with a sufficient Plastic solid, it is necessary to make it into 5kg/cm<sup>2</sup> or more. Furthermore, plating processing is performed in order to give oxidation resistance to the magnet ingredient manufactured by the above-mentioned process. This plating processing should just be compound plating of the metal which has oxidation resistance,

such as nickel, Cr, and Zn, alloy plating, nickel, Cr, etc., etc. that what is necessary is just to use the plating art usually performed. The art is performed by no electrolyzing or electrolytic plating, and Cu substrate plating usually applied to Fe system ingredient can also be used for it.

Moreover, the thickness has 25 micrometers or less more desirable than dimensional accuracy, a cost side, and an oxidation-resistant field.

The example is described below.

<Example -1> The ingot which makes the main phase the Nd<sub>2</sub>Fe<sub>14</sub>B phase which has the presentation of Nd<sub>13</sub>Fe<sub>81</sub>B<sub>6</sub> by high-frequency heating in an argon ambient atmosphere was obtained using Nd-Fe-B of 95% or more of purity. Next, after carrying out coarse grinding of this ingot, wet grinding of it was carried out to the mean particle diameter of about 4 micrometers using the ball mill. Next, the mixture which made 95vol% this obtained impalpable powder with the mixing ratio, and made remainder 5vol% one kind in Zn, aluminum, S, In, Ga, germanium, Te and Cu of 99.9% or more of purity, and Pb powder was adjusted, homogeneity distribution mixing of this mixed powder was carried out with the ball mill, and the mixed powder of nine kinds of Nd<sub>13</sub>Fe<sub>81</sub>B<sub>6</sub> and nonmagnetic powder was obtained. After fabricating these powder by the pressure of 1.0 t/cm<sup>2</sup> in 20KOe field, the hotpress of the pressure of 1.0 t/cm<sup>2</sup> was applied and carried out for 15 minutes under the temperature around 600 degrees C in a vacuum. Next, after carrying out substrate plating of Cu for the obtained magnet ingredient, electrolysis nickel plating was performed. When the plating thickness of this Cu+nickel was measured, it was 15 micrometers in 5-micrometer max at min. The magnet property of the magnet ingredient obtained from the hotpress which has not carried out plating processing for the test piece carried out in these plating processing and the comparison, and the sintered magnet which has the presentation of Nd<sub>15</sub>Fe eight B<sub>7</sub> which performed plating processing like the above is shown in the first table. Moreover, that to which oxidation resistance carried out Cu substrate plating +nickel plating processing of these magnets at the magnet obtained with the hotpress by this invention as a result of performing a salt spray test (JIS-Z -2371) for 48 hours had not produced change at all. However, in the magnet front face obtained with the hotpress which has not performed plating processing, rust was produced in the whole surface. Furthermore, rust also produced the sample which carried out Cu+nickel plating in the sintered magnet which has the presentation of Nd<sub>15</sub>Fe 78B<sub>7</sub> obtained by the sintering process, and breakaway of the plating film had arisen.

第一表

表面処理 組成	無処理			Cu下地メッキ+Hiメッキ		
	Br (kG)	(BH) <sub>max</sub> (MGoe)	Hc (kOe)	Br (kG)	(BH) <sub>max</sub> (MGoe)	Hc (kOe)
Nd <sub>1.2~3</sub> Fe <sub>7~7.7</sub> B <sub>5~7</sub> Zn <sub>5</sub>	13.5	42.2	10.8	13.4	42.0	10.5
Nd <sub>1.2~4</sub> Fe <sub>7~7.2</sub> B <sub>5~7</sub> Al <sub>4~7</sub>	14.0	45.0	12.5	14.0	45.2	12.8
Nd <sub>1.2~6</sub> Fe <sub>7~8.6</sub> B <sub>5~8</sub> In <sub>3</sub>	13.6	42.1	10.5	13.5	42.0	10.9
Nd <sub>1.2~5</sub> Fe <sub>7~7.7</sub> B <sub>5~8</sub> S <sub>4</sub>	13.9	42.0	10.0	13.7	41.0	10.2
Nd <sub>1.2~5</sub> Fe <sub>7~8</sub> B <sub>5~8</sub> Ga <sub>3~7</sub>	13.5	40.5	11.5	13.4	40.7	11.0
Nd <sub>1.2~5</sub> Fe <sub>7~8</sub> B <sub>5~8</sub> Ge <sub>3~7</sub>	13.7	40.0	10.8	13.7	40.0	10.5
Nd <sub>1.2~7</sub> Fe <sub>7~8.3</sub> B <sub>5~8</sub> Te <sub>2~1</sub>	13.8	38.0	7.5	13.7	38.2	7.0
Nd <sub>1.2~7</sub> Fe <sub>7~8.7</sub> B <sub>5~8</sub> Sm <sub>2~8</sub>	13.6	41.0	10.6	13.6	41.2	11.0
Nd <sub>1.2~2</sub> Fe <sub>7~8</sub> B <sub>5~8</sub> Cu <sub>6~1</sub>	13.4	39.0	9.0	13.3	38.8	9.2
Nd <sub>1.2~8</sub> Fe <sub>7~8.1</sub> B <sub>5~9</sub> Pb <sub>2~2</sub>	13.3	38.5	9.5	13.3	38.0	9.6

表面処理 組成	無処理			Cu下地メッキ+Hiメッキ		
	Br (kG)	(BH) <sub>max</sub> (MGoe)	Hc (kOe)	Br (kG)	(BH) <sub>max</sub> (MGoe)	Hc (kOe)
Nd <sub>1.5</sub> Fe <sub>8.1</sub> B <sub>5</sub>	1.0	0.2	<1	1.0	0.3	<1

比較例(焼結体)

Nd <sub>1.5</sub> Fe <sub>7.8</sub> B <sub>7</sub>	12.8	38.2	9.5	12.8	38.0	9.0
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## [Effect of the Invention]

As stated above, in this invention, pressing between heat is performed for the body in the magnetic powder which makes R2Fe14B phase the main phase, the mixed powder obtained from non-magnetic metal powder, or the end of powder compacting. The sake,